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In re patent application of

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Corres. to PCT/EP2004/013828

For: HEAT EXCHANGER, ESPECIALLY OIL/COOLANT COOLER

VERIFICATION OF TRANSLATION

Commissioner for Patents
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Sir:

I, Elisabeth Ann LUCAS,

Director of RWS Group Ltd, of Europa House, Marsham Way, Gerrards Cross, Buckinghamshire, England declare:

That the translator responsible for the attached translation is familiar with both the German and the English language, and that, to the best of RWS Group Ltd knowledge and belief, the attached English translation of International Application No. PCT/EP2004/013828 is a true, faithful and exact translation of the corresponding German language paper.

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July 6, 2006

Date

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Heat exchanger, especially oil/coolant cooler

The invention relates to a heat exchanger, especially a stacked plate oil cooler, having a plate-type design, in accordance with the precharacterizing clause of claim 1.

EP 0 623 798 A2 discloses a plate heat exchanger with trough-shaped heat exchanger plates which are stacked on one another and the encircling edges of which bear against one another and are soldered tightly to one another, with all of the heat exchanger plates having the same shape. In this case, the lowermost heat exchanger plate is closed by means of a closing plate, the closing plate bearing flat against the base of the heat exchanger plate and openings for connections being provided in the closing plate. The closing plate is of completely flat design. A known stacked plate oil cooler with a correspondingly designed closing plate is illustrated in figures 9 and 10.

A heat exchanger of this type still leaves something to be desired, in particular with regard to the stability of the same.

It is the object of the invention to provide an improved heat exchanger.

This object is achieved by a heat exchanger with the features of claim 1. Advantageous refinements are the subject matter of the subclaims.

According to the invention, a heat exchanger, in particular stacked plate oil cooler, having a plate-type design, is provided, in which the base plate

has a recessed surface corresponding to the adjacent heat exchanger plate. In this case, in particular the flanks of the outermost heat exchanger plate bear, at least in their lower region, against the flanks of the contour of the base plate, which contour runs in a recessed manner. The form-fitting bearing results in a large contact surface and therefore connecting surface between the outermost heat exchanger plate and the base plate, so that, with a corresponding connection by means of solder or the like, there is a good connection and therefore optimum transmission of force, so that the base plate leads to a significantly increased stability of the heat exchanger.

Preferably, one edge of the outermost heat exchanger plate protrudes over the base plate, at least in its edge region, in which it is connected to the adjacent heat exchanger plate.

The depression in the base plate is greater than the material thickness of the outermost heat exchanger plate of the heat exchanger, and is preferably at least as deep as the material thickness of the heat exchanger plate of the heat exchanger plus half of the clear height between the outermost heat exchanger plate, which bears against the base plate, and the second outermost heat exchanger plate. A depth of the depression which is at least as deep as the material thickness of the heat exchanger plate of the heat exchanger plus the clear height between the outermost heat exchanger plate, which bears against the base plate, and the second outermost heat exchanger plate, is optimum.

The contour in the base plate is preferably produced by means of embossing or machining. Other production methods are possible, for example, the base plate can

be cast.

Heat exchangers according to the invention can be used, on the one hand, as oil coolers but also as evaporators or condensers or else, for example, as a charge-air/coolant cooler. In this case, the refrigeration cycle of a device of this type can serve not only to air-condition a (vehicle) interior but also to cool heat sources, such as electrical consumers, energy stores and voltage sources or the charge air of a turbocharger. The heat exchanger is a condenser when heat exchange takes place, for example, as a result of condensation of the refrigerant of an air-conditioning system in a coolant-loaded compact heat exchanger and the coolant discharges the heat in a heat exchanger to air as a further medium. The evaporation or condensation of another medium in a heat exchanger designed according to the invention may also take place, for example, in applications in fuel cell systems.

A method according to the invention for the production of a heat exchanger, in particular a heat exchanger according to the invention, makes provision for the base plate to be produced by embossing of the same, followed by a correspondingly oriented stacking of the heat exchanger plates and of the base plate and then connection by brazing takes place. In this case, in particular, connection of the plates by brazing takes place such that the plates are sealingly connected to one another at their edge and, in particular, at the same time a connection of adjacent plates at the contact points of profiles takes place. In a particularly advantageous refinement, a stable and distortion-resistant element is thereby produced.

The invention is explained in detail below using four

exemplary embodiments together with variants with reference to the drawing, in which:

fig. 1a shows a section through a stacked plate oil cooler along the line A-A of fig. 3 according to the first exemplary embodiment,

Fig. 1b shows a section through a stacked plate oil cooler along the line A-A of fig. 3 according to a variant of the first exemplary embodiment,

Fig. 2 shows a perspective illustration of the stacked plate oil cooler of fig. 1a,

Fig. 3 shows a plan view of the stacked plate oil cooler of fig. 1a,

Fig. 4b shows a section through a stacked plate oil cooler according to a variant of the second exemplary embodiment,

Fig. 5 shows a section through a stacked plate oil cooler according to the third exemplary embodiment,

Fig. 6 shows a section through a stacked plate oil cooler according to the fourth exemplary embodiment,

Fig. 7 shows a view of a detail of fig. 6,

Fig. 8 shows a heat exchanger plate according to the third and fourth exemplary embodiment,

Fig. 9 shows a section through a stacked plate oil cooler according to the prior art, and

Fig. 10 shows a view of the detail B from fig. 9.

A stacked plate oil cooler 1 serving as a heat exchanger, as disclosed, for example, in EP 0 623 798 A2, the disclosure content of which is expressly incorporated herein, has a plurality of punched and deep-drawn heat exchanger plates 2 which are stacked on one another and between which coolant and oil flows in an alternating sequence. The flow direction at the coolant connections is indicated in fig. 2 by arrows. The oil is supplied and removed at the bottom.

To attach the oil connections and to mount the stacked plate oil cooler 1, a base plate 3 is attached to the lower side of the lowermost heat exchanger plate 2. As illustrated in fig. 1a, this base plate 3 has a depression 5, in the present case according to the first exemplary embodiment, a recess, on its upper side 6, which recess is provided with a contour corresponding, at least in its lower, flat regions and in the region of the flanks, to the lower side of the lowermost heat exchanger plate 2. The depression 5 has been milled out of the rectangular base plate 3 by means of milling, with the lower side of the base plate 3 being unchanged in its shape.

The depression 5 has a depth which corresponds approximately to the material thickness of the lowermost heat exchanger plate 2 plus the clear height between the two lower heat exchanger plates 2.

According to a variant of the first exemplary embodiment, the depression 5 is formed somewhat lower than the depression 5 of the first exemplary embodiment, in the present case approximately twice the material thickness of the heat exchanger plates 2 plus

the clear height between the two lowermost heat exchanger plates 2.

According to the second exemplary embodiment, which is illustrated in fig. 4a and essentially corresponds to the first exemplary embodiment, in order to avoid excessive displacements of material during machining, the base plate 3 has, on its lower side, a protruding region 8, approximately in a region as a continuation of the heat exchanger plates 2. In this case, the protruding region 8 has a flat base. By means of the protruding region 8, a greater depth of the depression 6 is made possible with the least possible deformation and displacement of material of the base plate 3.

According to a variant illustrated in fig. 4b, the depth of the depression 5 corresponds approximately to the depth of the depression 5 according to the variant of the first exemplary embodiment.

Fig. 5 illustrates as a third exemplary embodiment a section through a stacked plate oil cooler 1 which is formed from interconnected heat exchanger plates 2 and a base plate 3. Cavities closed off outwardly are formed between the heat exchanger plates 2. The cavities are alternately supplied with a first and a second medium in each case via at least one inflow and outflow line and the corresponding medium also flows through them. In this case, the plates are profiled in such a way that contact points occur between the respective profiles of the heat exchanger plates 2. The heat exchanger plates 2 are connected to one another with a cohesive material joint, as a rule are soldered, in the region of these contact points. At the same time, the heat exchanger plates 2 are configured in such a manner that the flow, which forms between the heat exchanger plates 2, of the first or second medium

from the corresponding inflow line to the corresponding outflow line does not run rectilinearly. An example of a heat exchanger plate 2 of this type is illustrated in fig. 8.

In this case, the heat exchanger plates 2 can have a recurring wavy profile which then runs at least in a direction transverse with respect to the throughflow direction which is the straight connection from the inlet points of the medium to the outlet points. The wavy profile runs around this direction in a zigzag-shaped manner. Such a wavy profile in a simple manner forms flow guide regions which are suitable for guiding the flow of the medium flowing through the corresponding cavity. The flow is thereby advantageously multiply deflected in its run or flows through regions in which the distance of the heat exchanger plates 2 from one another differs in size. Therefore, the flow velocity varies in these regions. The effect is advantageously achieved at the same time that, overall, the medium is distributed over the entire surface of the heat exchanger plates 2 and therefore the entire heat exchange surface is utilized in as an optimized a manner as possible. Even turbulent flows arise as a function of the flow behavior (viscosity) of the medium flowing through. The repeatedly occurring changes in direction of the fluid in the duct and the vortexes which, under some circumstances, form in the region of the opening wave duct repeatedly break up the boundary layer formed. This leads to an improved heat transmission.

Alternatively, the wavy profile can have legs running rectilinearly between flow regions, the run of the wavy profile being characterized by the leg length of the legs, by the leg angle defined between the legs and by the profile depth of the wavy profile. The profile of a

wavy profile is fixed in its cross section by the run in the region of the legs and in the region of curvature, with it being possible for preferred refinements to provide a deviation in the cross-sectional form in these regions.

The wavy profile, which runs in a zigzag-shaped manner, of the heat exchanger plates 2, is characterized in this case particularly by the leg length, the leg angle between adjacent legs and the profile depth. Preferred refinements of the invention make provision for the leg length to be in the range of 8 to 15 mm, preferably in the range of 9 to 12 mm. Typical values of the profile depth - which is calculated, for example, from the distance between a wave crest and the plate center plane - are in the range of 0.3 to 1.5 mm. For many applications, a profile depth of between 0.5 and 1 mm may be advantageous, while values of approximately 0.75 mm may be preferred. The leg angle between two legs of the wavy profile is preferably between 45° and 135°. In particular values around 90° constitute a good compromise with regard to the distribution of fluid, the throughflow velocity and the throughflow capacity of the heat exchanger. The leg length and the leg angle define, on the one hand, the flow guide function of the wavy profile but, on the other hand, also contact points of adjacent heat exchanger plates 2 against one another, which is required for the stability of the heat exchanger. The inherent rigidity of the heat exchanger plates 2 with respect to compressive action by the media cannot be ensured without mutual support if the selected material thickness of the heat exchanger plate 2 is low, as is desirable in many applications for reasons of weight saving and heat exchange. In this case, in a preferred refinement, a connection of the heat exchanger plates 2 takes place in the region of the contact points by brazing, for

which purpose the heat exchanger plates 2 are coated at least on one side with a soldering aid, such as a solder. The selection of leg length and leg angle takes place preferably as a function of the medium flowing through and its viscosity. The leg length and leg angle have a great influence on the flow velocities occurring and on the heat exchange associated therewith, so that these are adapted to the respective intended use. The abovementioned values in this case relate particularly to the use of heat exchangers as oil coolers in vehicles where the heat exchange takes place between engine oil and cooling water. Furthermore, they also depend, of course, on the dimensioning of the heat exchanger plates 2 and of the interspace occurring due to the distance between the heat exchanger plates 2.

The configuration of the wavy profile is fixed essentially by the form of the cross section perpendicularly to the outer edge of the profile in this region and by the profile sequence, fixed by the division, in the run transverse with respect to the direction of extent of a wavy profile over the heat exchanger plate 2. Preferred refinements provide a constant division, that is to say a fixed distance between any two wavy profiles adjacent to one another. The configuration of the wavy profile is advantageous particularly when it has a flat region on the outside of the wave back. The flat region in this case has, in particular, a width of 0.1 to 0.4 mm. The flat region makes it possible for heat exchanger plates 2 adjacent to one another to bear effectively against one another over a large area and consequently allows easy and stable production of the support or connection - such as by brazing - of adjacent heat exchanger plates 2 to one another.

The heat exchanger plates 2 may be configured identically or correspondingly or similarly to one another or differently from one another. Heat exchanger plates 2 which are identical to one another have identical properties in terms of the characteristic properties of the wavy profile and the configuration of the wavy profile. Heat exchanger plates 2 corresponding to one another are identical to one another in construction, but is it possible, for example, for the heat exchanger plates 2 to have different leg angles from one another. Heat exchanger plates 2 corresponding to one another preferably have configurations of the wavy profile which are different from one another and/or values, which are different from one another, of characterizing parameters, but correspond to one another in terms of the design of the edge and the design of the front and the rear side of the heat exchanger plates 2. The alternating use of, for example, two heat exchanger plates 2 which correspond to one another and differ only in different leg angles in the characteristic parameters, has the advantage that the position and relative situation of contact points of the heat exchanger plates 2 against one another in the profiled region can be optimized in a simple manner in terms of the required rigidity and the required throughflow.

The material of the heat exchanger plates 2 and of the base plate 3 in the present case is aluminum. The advantage of this material is that it has low density and at the same time makes it possible to produce the wavy profile, for example, by embossing in a simple manner. To produce the connection between two adjacent plates, at least one side may be coated over its entire surface with soldering aid, such as brazing alloy, in the region of the contact points and in the region of the edges. Depending on the selection of the soldering

aid and of the layer thickness of the application of the soldering aid, coating on both sides with soldering aid may also be provided. The coating with soldering aid is to serve, in particular in the region of the edges and of the inflow and outflow lines in the block, for the reliable production of a fluid-tight connection of two plates to each other in a joining operation by means of a joining tool (brazing furnace), without the use of further aids or auxiliaries.

The connection between the heat exchanger plates 2 and between the lowermost heat exchanger plate 2 and the base plate 3 is produced, in particular, by brazing. In order to achieve a good sealing action and at the same time a stable construction of the heat exchanger in the region of the edge of the heat exchanger plates 2, there may be provision for the heat exchanger plates 2 to have a bent edge, the height of which is selected such that at least two heat exchanger plates 2 adjacent to one another bear against one another and mutually overlap in this edge region. The number of heat exchanger plates 2 overlapping in the edge region may in this case be up to five. The larger the number of overlapping heat exchanger plates 2 is, the more rigid is the wall formed thereby and outwardly closing off the heat exchanger. This is at the same time conducive to the production of a permanently stable, resistant, fluid-tight outward closure of the heat exchanger plates 2. In this case, preferred developing refinements make provision for the wavy profile to extend into the edge and, in particular, over its entire width. At the same time, it is necessary to ensure, in the configuration of the wavy profile, that the heat exchanger plates 2 nevertheless remain stackable, this being achieved in that the run of the wavy profile in the edge region is coordinated with the

mounting position of two adjacent heat exchanger plates 2 with respect to each other.

Figures 6 and 7 show a modification, corresponding to the third exemplary embodiment, with a base plate 3 which has, on its lower side, a protruding region 8 approximately as a continuation of the heat exchanger plates 2. Also according to this exemplary embodiment, the protruding region 8 has a flat base.

List of Designations

1	Stacked plate oil cooler
2	Heat exchanger plate
3	Base plate
5	Depression
6	Upper side
8	Protruding region